

## Ultra-Small High-Side MOSFET Driver

### Features

- 2.75V to 30V Operation
- 100  $\mu$ A Maximum Supply Current (5V supply)
- 15  $\mu$ A Typical Off-State Current
- Internal Charge Pump
- TTL Compatible Input
- Withstands 60V Transient (Load Dump)
- Reverse Battery Protected To  $-20$ V
- Inductive Spike Protected To  $-20$ V
- Overvoltage Shutdown at 35V
- Internal 15V Gate Protection
- Minimum External Parts
- Operates in High-Side or Low-Side Configurations
- 1  $\mu$ A Control Input Pull-Off
- Available in 8-Lead 3 mm x 3 mm VDFN Package

### Applications

- Notebook Battery Safety Switches
- UMPC and Web Tablet Battery Protection
- Battery-Powered Computer Power Management
- General MOSFET Switch Applications
- Power Bus Switching

### General Description

The MIC5060 MOSFET driver is designed for gate control of N-Channel, enhancement-mode, and power MOSFETs used as high-side or low-side switches. The MIC5060 can sustain an on-state output indefinitely.

The MIC5060 operates from a 2.75V to 30V supply. In high-side configurations, the driver can control MOSFETs that switch loads of up to 30V. In low-side configurations, with separate supplies, the maximum switched voltage is limited only by the MOSFET.

The MIC5060 has a non-inverting, TTL-compatible control input.

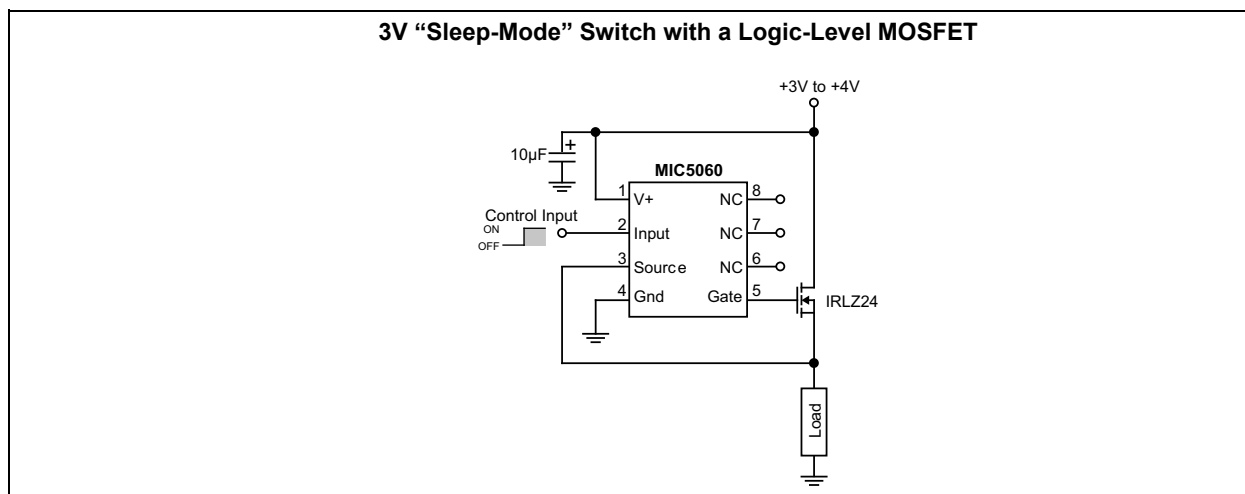
The MIC5060 features an internal charge pump that can sustain a gate voltage greater than the available supply voltage. The driver is capable of turning on a logic-level MOSFET from a 2.75V supply or a standard MOSFET from a 5V supply. The gate-to-source output voltage is internally limited to approximately 15V.

The MIC5060 is protected against automotive load dump, reversed battery, and inductive load spikes of  $-20$ V.

The driver's overvoltage shutdown feature turns off the external MOSFET at approximately 35V to protect the load against power supply excursions.

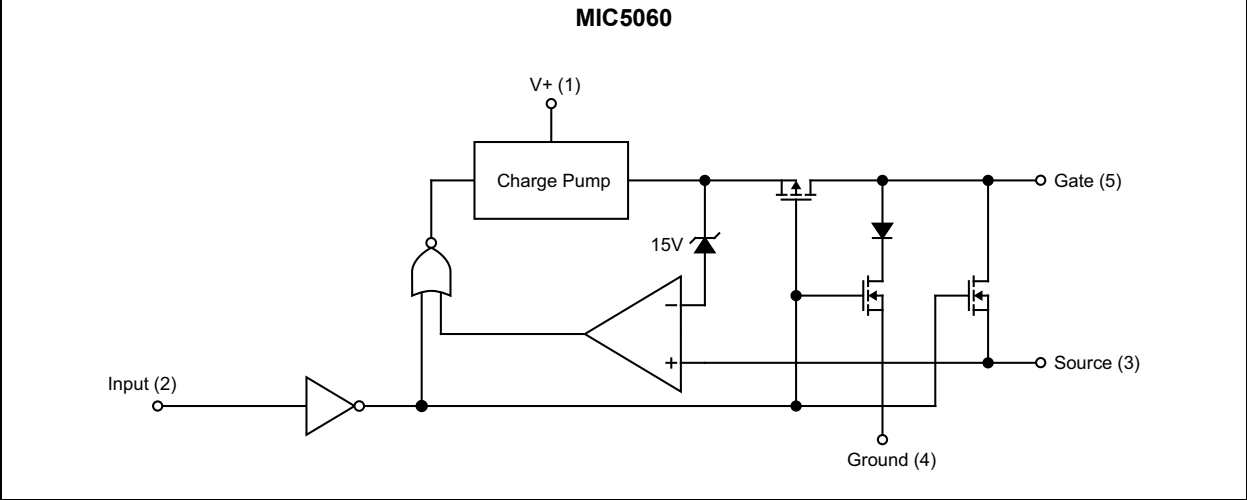
The MIC5060 is available in a 3 mm x 3 mm VDFN package.

### Typical Application Circuit



# MIC5060

## Functional Block Diagram



## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings †

Supply Voltage .....	-20V to +40V
Input Voltage .....	-20V to V+ + 0.3V
Source Voltage.....	-20V to V+
Source Current.....	+50 mA
Gate Voltage .....	-20V to +50V

### Operating Ratings ‡

Supply Voltage .....	+2.75V to +30V
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† **Notice:** Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

‡ **Notice:** The device is not guaranteed to function outside its operating ratings.

**Note 1:** Devices are ESD sensitive. Handling precautions are recommended. Human body model, 1.5 kΩ in series with 100 pF.

## ELECTRICAL CHARACTERISTICS

Electrical Characteristics: $T_J = T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ unless otherwise specified. <a href="#">Note 1</a>							
Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions	
Supply Current	$I_{V+}$	—	10	25	$\mu\text{A}$	$V+ = 30\text{V}$	$V_{IN}$ De-Asserted, <a href="#">Note 2</a>
			5.0	<b>10</b>			$V_{IN}$ Asserted, <a href="#">Note 2</a>
			10	<b>25</b>		$V+ = 5\text{V}$	$V_{IN}$ De-Asserted, <a href="#">Note 2</a>
			60	<b>100</b>			$V_{IN}$ Asserted, <a href="#">Note 2</a>
			10	<b>25</b>		$V+ = 3\text{V}$	$V_{IN}$ De-Asserted, <a href="#">Note 2</a>
			25	<b>35</b>			$V_{IN}$ Asserted, <a href="#">Note 2</a>
Logic Input Voltage Threshold $V_{IN}$	$V_{IH}$	—	—	0.8	V	$2.75\text{V} \leq V+ \leq 30\text{V}$ $T_A = 25^{\circ}\text{C}$	Digital Low Level
	$V_{IL}$	2.0	—	—		$2.75\text{V} \leq V+ \leq 30\text{V}$	Digital High Level
Logic Input Current MIC5060	$I_{IN\_L}$	-2.0	0	—	$\mu\text{A}$	$3.0\text{V} \leq V+ \leq 30\text{V}$	$V_{IN}$ low
	$I_{IN\_H}$	—	1.0	2.0		$8.0\text{V} \leq V+ \leq 30\text{V}$	$V_{IN}$ high
Gate Enhancement $V_{GATE} - V_{SUPPLY}$	$V_{G\_EN}$	3.0	—	17	V	$3.0\text{V} \leq V+ \leq 30\text{V}$	$V_{IN}$ Asserted
Zener Clamp $V_{GATE} - V_{SOURCE}$	$V_{OH}$	13	15	17	V	$8.0\text{V} \leq V+ \leq 30\text{V}$	$V_{IN}$ Asserted

# MIC5060

## ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: $T_J = T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ unless otherwise specified. <a href="#">Note 1</a>							
Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions	
Gate Turn-on Time, $t_{ON}$ <a href="#">Note 3</a>	$t_R$	—	2.5	8.0	ms	$V_+ = 4.5\text{V}$ $C_L = 1000\text{ pF}$	$V_{IN}$ switched on, measure time for $V_{GATE}$ to reach $V_+ + 4\text{V}$
		—	90	140	$\mu\text{s}$	$V_+ = 12\text{V}$ $C_L = 1000\text{ pF}$	As above, measure time for $V_{GATE}$ to reach $V_+ + 4\text{V}$
Gate Turn-off Time, $t_{OFF}$ <a href="#">Note 3</a>	$t_F$	—	6.0	30	$\mu\text{s}$	$V_+ = 4.5\text{V}$ $C_L = 1000\text{ pF}$	$V_{IN}$ switched on, measure time for $V_{GATE}$ to reach 1V
		—	6.0	30	$\mu\text{s}$	$V_+ = 12\text{V}$ $C_L = 1000\text{ pF}$	As above, measure time for $V_{GATE}$ to reach 1V
Overvoltage Shutdown Threshold	$OV_{SHDN}$	35	37	41	V	—	—

- Note 1:** Minimum and maximum Electrical Characteristics are 100% tested at  $T_A = 25^{\circ}\text{C}$  and  $T_A = 85^{\circ}\text{C}$ . Typical values are characterized at  $25^{\circ}\text{C}$  and represent the most likely parametric norm.
- 2:** “Asserted” refers to a logic high on the MIC5060.
- 3:** Test conditions reflect worst-case high-side driver performance. Low-side and bootstrapped topologies are significantly faster - see Applications Information.

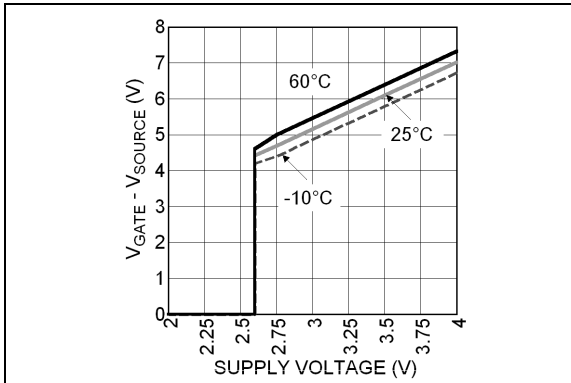
## TEMPERATURE SPECIFICATIONS

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
<b>Temperature Ranges</b>						
Storage Temperature Range	$T_S$	-65	—	+150	$^{\circ}\text{C}$	—
Junction Temperature	$T_J$	—	—	+150	$^{\circ}\text{C}$	<a href="#">Note 1</a>
Ambient Temperature	$T_A$	-40	—	+85	$^{\circ}\text{C}$	—
Lead Temperature	—	—	—	+260	$^{\circ}\text{C}$	Soldering, 10 sec.
<b>Package Thermal Resistances</b>						
Thermal Resistance, VDFN-8	$\theta_{JA}$	—	60	—	$^{\circ}\text{C}/\text{W}$	—

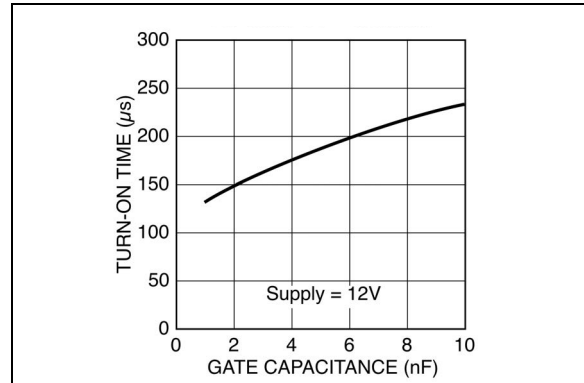
- Note 1:** The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e.,  $T_A$ ,  $T_J$ ,  $\theta_{JA}$ ). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum  $+150^{\circ}\text{C}$  rating. Sustained junction temperatures above  $+150^{\circ}\text{C}$  can impact the device reliability.

## 2.0 TYPICAL PERFORMANCE CURVES

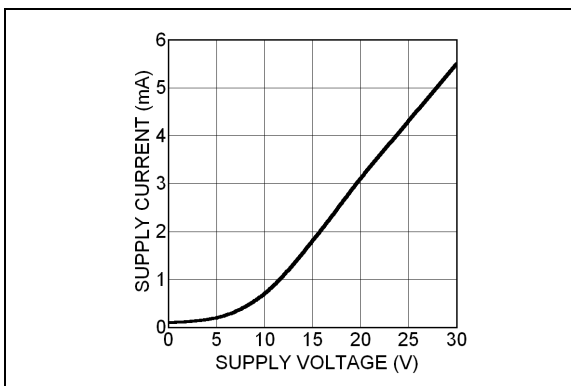
**Note:** The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.



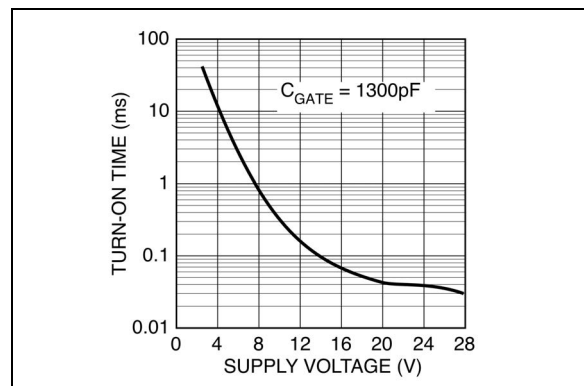
**FIGURE 2-1:**  $V_{GATE} - V_{SOURCE}$  vs. Supply Voltage.



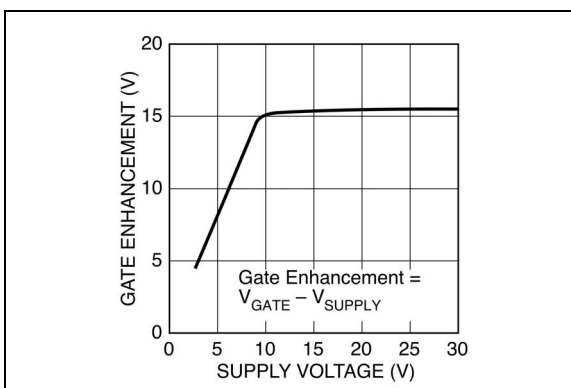
**FIGURE 2-4:** High-Side Turn-On Time vs. Gate Capacitance.



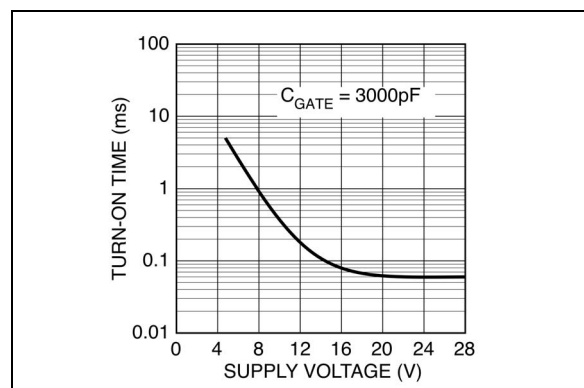
**FIGURE 2-2:** Supply Current (Output Asserted).



**FIGURE 2-5:** High-Side Turn-On Time Until Gate = Supply +4V.

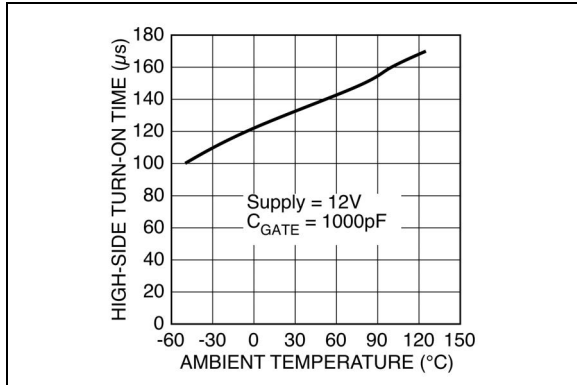


**FIGURE 2-3:** Gate Enhancement vs. Supply Voltage.

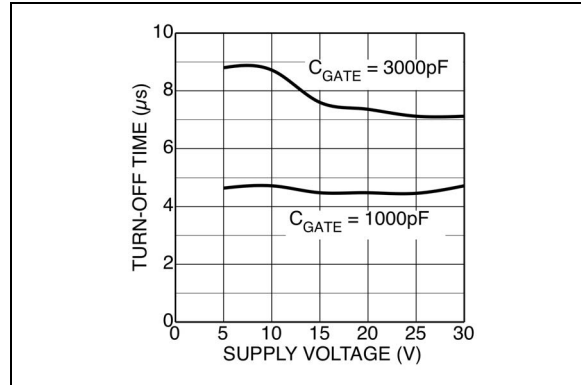


**FIGURE 2-6:** High-Side Turn-On Time Until Gate = Supply +4V.

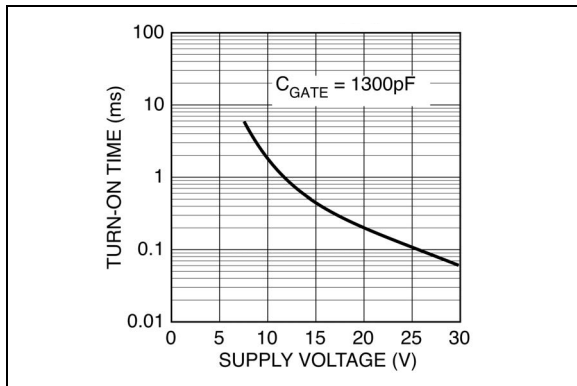
# MIC5060



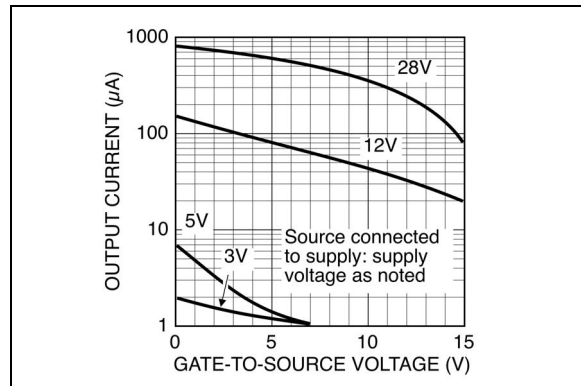
**FIGURE 2-7:** High-Side Turn-On Time vs. Temperature.



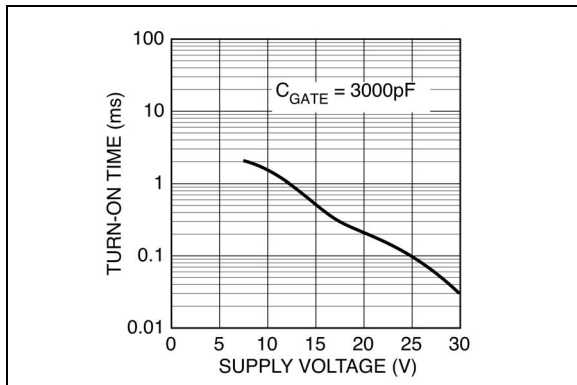
**FIGURE 2-10:** High-Side Turn-Off Time Until Gate = Supply +1V.



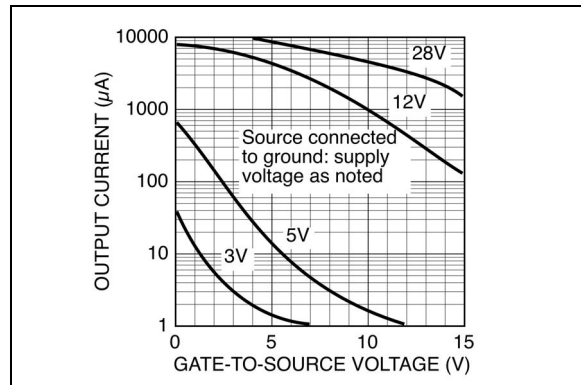
**FIGURE 2-8:** High-Side Turn-On Time Until Gate = Supply +10V.



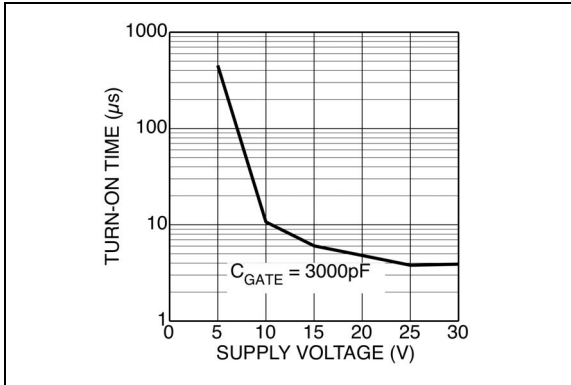
**FIGURE 2-11:** Charge Pump Output Current.



**FIGURE 2-9:** High-Side Turn-On Time Until Gate = Supply +10V.



**FIGURE 2-12:** Charge Pump Output Current.



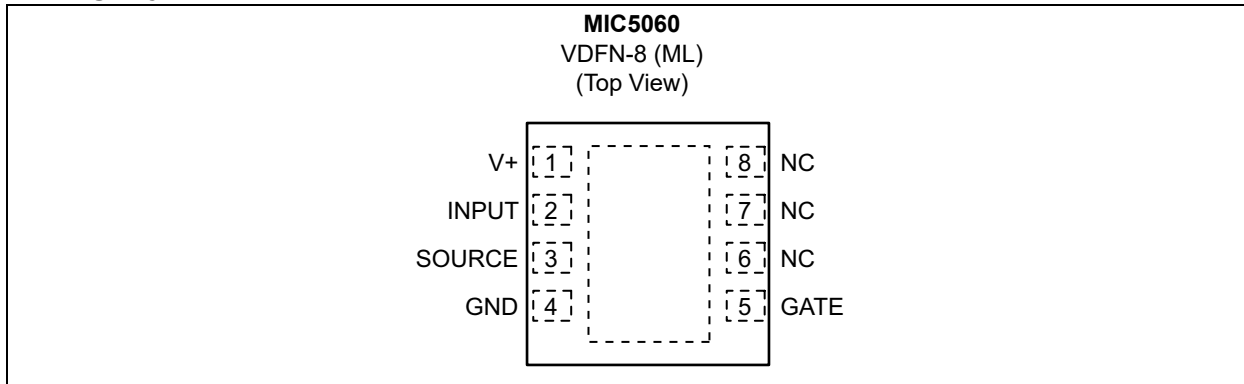
**FIGURE 2-13:** Low-Side Turn-On Time Until Gate = Supply 4V.

# MIC5060

## 3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in [Table 3-1](#).

### Package Type



**TABLE 3-1: PIN FUNCTION TABLE**

Pin Number	Pin Name	Description
1	V+	Supply. Must be decoupled to isolate from large transients caused by the power MOSFET drain. 10 $\mu$ F is recommended close to pins 1 and 4.
2	INPUT	Turns on power MOSFET when taken above (or below) threshold (1.0V typical). Pin 2 requires $\sim 1 \mu$ A to switch.
3	SOURCE	Connects to source lead of power MOSFET and is the return for the gate clamp zener. Pin 3 can safely swing to $-20$ V when turning off inductive loads.
4	GROUND	Ground.
5	GATE	Drives and clamps the gate of the power MOSFET.
6, 7, 8	NC	Not internally connected.



## 4.0 APPLICATION INFORMATION

### 4.1 Functional Description

The internal functions of the MIC5060 is controlled via a logic block (refer to the [Functional Block Diagram](#)) connected to the control input (Pin 2). When the input is off (low), all functions are turned off, and the gate of the external power MOSFET is held low via two N-Channel switches. This results in a very low standby current, 15  $\mu$ A typical, which is necessary to power an internal bandgap.

When the input is driven to the "ON" state, the N-Channel switches are turned off, the charge pump is turned on, and the P-Channel switch between the charge pump and the gate turns on, allowing the gate of the power FET to be charged. The op amp and internal zener form an active regulator which shuts off the charge pump when the gate voltage is high enough.

The charge pump incorporates a 100 kHz oscillator and on-chip pump capacitors capable of charging a 1000 pF load in 90  $\mu$ s typical. In addition to providing active regulation, the internal 15V zener is included to prevent exceeding the VGS rating of the power MOSFET at high supply voltages.

The MIC5060 device has been improved for greater ruggedness and durability. All pins can withstand being pulled 20V below ground without sustaining damage, and the supply pin can withstand an overvoltage transient of 60V for 1 second. An overvoltage shutdown has also been included, which turns off the device when the supply exceeds 35V.

### 4.2 Construction Hints

High current pulse circuits demand equipment and assembly techniques that are more stringent than normal, low current lab practices. The following are the sources of pitfalls most often encountered during prototyping: Supplies. Many bench power supplies have poor transient response. Circuits that are being pulse tested, or those that operate by pulse-width modulation will produce strange results when used with a supply that has poor ripple rejection, or a peaked transient response. Always monitor the power supply voltage that appears at the drain of a high side driver (or the supply side of the load for a low side driver) with an oscilloscope. It is not uncommon to find bench power supplies in the 1 kW class that overshoot or undershoot by as much as 50% when pulse loaded. Not only will the load current and voltage measurements be affected, but also it is possible to over stress various components, especially electrolytic capacitors, with possibly catastrophic results. A 10  $\mu$ F supply bypass capacitor at the chip is recommended. Residual resistances: Resistances in circuit connections may also cause confusing results. For example, a circuit may employ a 50 m $\Omega$  power

MOSFET for low voltage drop, but unless careful construction techniques are used, one could easily add 50 m $\Omega$  to 100 m $\Omega$  resistance. Do not use a socket for the MOSFET. If the MOSFET is a TO-220 type package, make high current connections to the drain tab. Wiring losses have a profound effect on high-current circuits. A floating milliohmeter can identify connections that are contributing excess drop under load.

### 4.3 Low Voltage Testing

As the MIC5060 has relatively high output impedances, a normal oscilloscope probe will load the device. This is especially pronounced at low voltage operation. It is recommended that a FET probe or unity gain buffer be used for all testing.

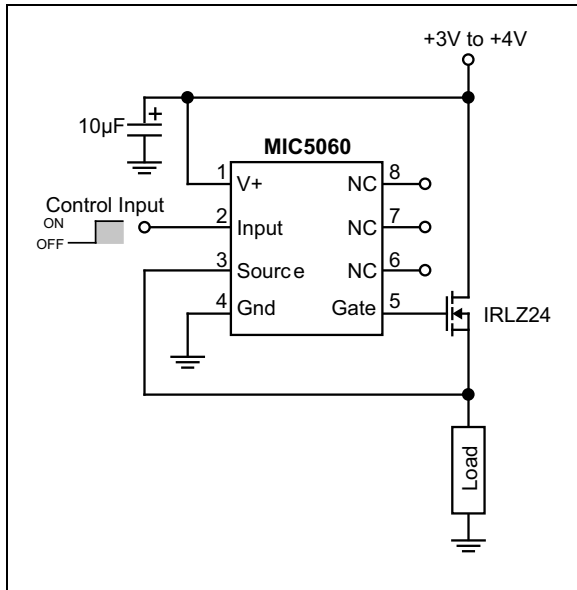
### 4.4 Circuit Topologies

The MIC5060 is well suited for use with standard power MOSFETs in both low- and high-side driver configurations. In addition, the lowered supply voltage requirements of these devices make them ideal for use with logic level FETs in high side applications with a supply voltage of 3V to 4V. (If higher supply voltages [ $>4$ V] are used with logic level FETs, an external zener clamp must be supplied to ensure that the maximum  $V_{GS}$  rating of the logic FET [10V] is not exceeded.) In addition, a standard IGBT can be driven using these devices.

Choice of one topology over another is usually based on speed vs. safety. The fastest topology is the low side driver, however, it is not usually considered as safe as high side driving as it is easier to accidentally short a load to ground than to  $V_{CC}$ . The slowest, but safest topology is the high side driver; with speed being inversely proportional to supply voltage. It is the preferred topology for most military and automotive applications. Speed can be improved considerably by bootstrapping from the supply.

All topologies implemented using these devices are well suited to driving inductive loads, as either the gate or the source pin can be pulled 20V below ground with no effect.

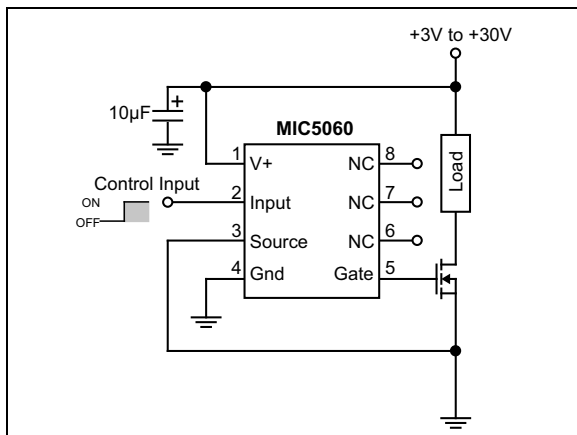
External clamp diodes are unnecessary, except for the case in which a transient may exceed the overvoltage trip point.



**FIGURE 4-1:** 3V Sleep-Mode Switch with a Logic-Level MOSFET.

## 4.5 High-Side Driver

The high side topology shown in Figure 4-1 is an implementation of a “sleep-mode” switch for a laptop or notebook computer, which uses a logic level FET. A standard power FET can easily be substituted when supply voltages above 4V are required.



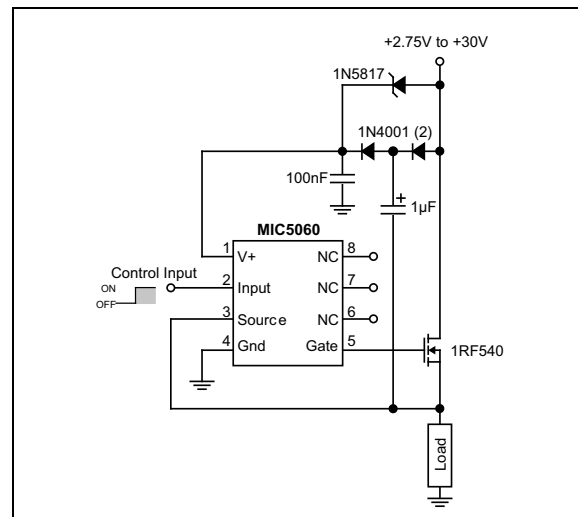
**FIGURE 4-2:** Low-Side Driver.

## 4.6 Low-Side Driver

A key advantage of this topology, as previously mentioned, is speed. The MOSFET gate is driven to near supply immediately when the MIC5060 is turned on. Typical circuits reach full enhancement in 50 µs or less with a 15V supply.

## 4.7 Bootstrapped High Side Driver

The turn-on time of a high side driver can be improved to faster than 40 µs by bootstrapping the supply with the MOSFET source. The Schottky barrier diode prevents the supply pin from dropping more than 200 mV below the drain supply and improves turn-on time. Since the supply current in the “off” state is only a small leakage, the 100 nF bypass capacitor tends to remain charged for several seconds after the MIC5060 is turned off. Faster speeds can be obtained at the expense of supply voltage (the overvoltage shutdown will turn the part off when the bootstrapping action pulls the supply pin above 35V) by using a larger capacitor at the junction of the two 1N4001 diodes. In a PWM application (this circuit can be used for either PWM’ed or continuously energized loads), the chip supply is sustained at a higher potential than the system supply, which improves switching time.



**FIGURE 4-3:** Bootstrapped High-Side Driver.

## 4.8 High-Side Driver with Current Sense

Although no current sense function is included on the MIC5060, a simple current sense function can be realized via the addition of one more active component; an LM301A op amp used as a comparator. The positive rail of the op amp is tied to V+, and the negative rail is tied to ground. This op amp was chosen as it can withstand having input transients that swing below the negative rail, and has common mode range almost to the positive rail.

The inverting side of this comparator is tied to a voltage divider, which sets the voltage to  $V+ - V_{TRIP}$ . The non inverting side is tied to the node between the drain of the FET and the sense resistor. If the overcurrent trip point is not exceeded, this node will always be pulled above  $V+ - V_{TRIP}$ , and the output of the comparator will be high which feeds the control input of the MIC5060.

Once the overcurrent trip point has been reached, the comparator will go low, which shuts off the MIC5060. When the short is removed, feedback to the input pin insures that the MIC5060 will turn back on. This output can also be level shifted and sent to an I/O port of a microcontroller for intelligent control.

**Current Shunts (RS).** Low valued resistors are necessary for use at RS. Resistors are available with values ranging from 1 mΩ to 50 mΩ, at 2W to 10W. If a precise overcurrent trip point is not necessary, then a non-precision resistor or even a measured PCB trace can serve as RS. The major cause of drift in resistor values with such resistors is temperature coefficient; the designer should be aware that a linear, 500 ppm/°C change will contribute as much as 10% shift in the overcurrent trip point. If this is not acceptable, a power resistor designed for current shunt service (drifts less than 100 ppm/°C), or a Kelvin-sensed resistor may be used.†

† **Suppliers of Precision Power Resistors:**

Dale Electronics, Inc., 2064 12th Ave., Columbus, NE 68601

(402) 565-3131

International Resistive Co., P.O. Box 1860, Boone, NC 28607-1860

(704) 264-8861

Isotek Corp., 566 Wilbur Ave., Swansea, MA 02777

(508) 673-2900

Kelvin, 14724 Ventura Blvd., Ste. 1003, Sherman Oaks, CA 91403-3501

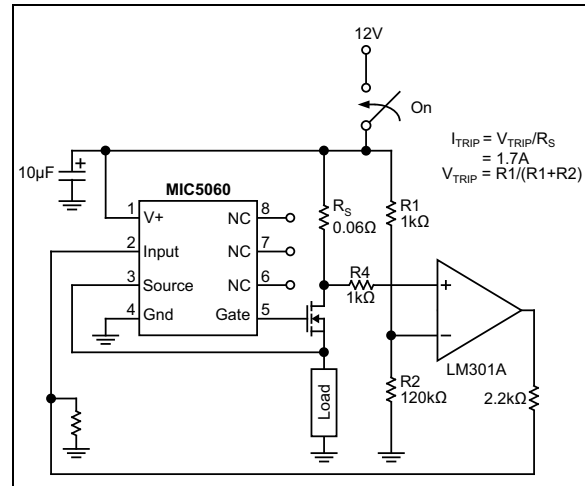
(818) 990-1192

RCD Components, Inc., 520 E. Industrial Pk. Dr., Manchester, NH 03103

(603) 669-0054

Ultronix, Inc., P.O. Box 1090, Grand Junction, CO 81502

(303) 242-0810



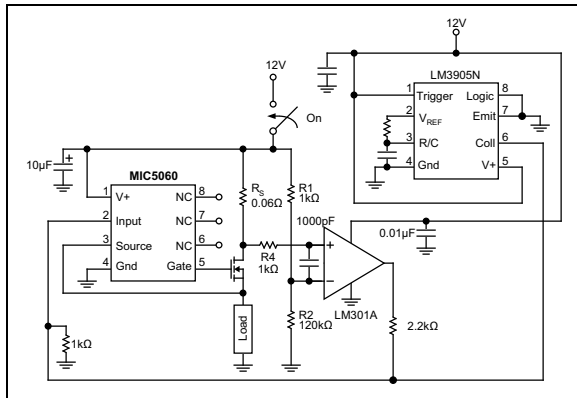
**FIGURE 4-4:** High-Side Driver with Overcurrent Shutdown.

# MIC5060

## 5.0 TYPICAL APPLICATIONS

### 5.1 Variable Supply Low-Side Driver for Motor Speed Control

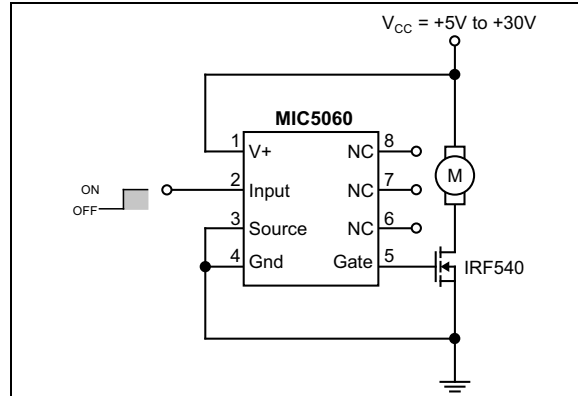
The internal regulation in the MIC5060 allows a steady gate enhancement to be supplied while the MIC5060 supply varies from 5V to 30V, without damaging the internal gate to source zener clamp. This allows the speed of the DC motor shown to be varied by varying the supply voltage.



**FIGURE 5-1:** DC Motor Speed Control/Driver.

### 5.2 Solenoid Valve Driver

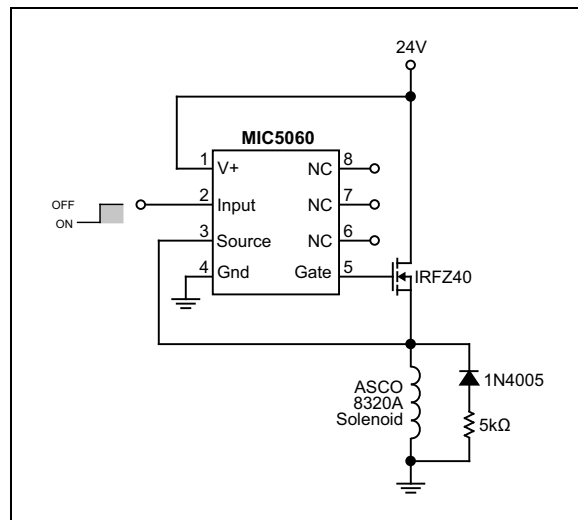
High power solenoid valves are used in many industrial applications requiring the timed dispensing of chemicals or gases. When the solenoid is activated, the valve opens (or closes), releasing (or stopping) fluid flow. A solenoid valve, like all inductive loads, has a considerable “kickback” voltage when turned off, as current cannot change instantaneously through an inductor. In most applications, it is acceptable to allow this voltage to momentarily turn the MOSFET back on as a way of dissipating the inductor’s current. However, if this occurs when driving a solenoid valve with a fast switching speed, chemicals or gases may be inadvertently be dispensed at the wrong time with possibly disastrous consequences. Also, too large of a kickback voltage (as is found in larger solenoids) can damage the MIC5060 or the power FET by forcing the Source node below ground (the MIC5060 can be driven up to 20V below ground before this happens). A catch diode has been included in this design to provide an alternate route for the inductive kickback current to flow. The 5 kΩ resistor in series with this diode has been included to set the recovery time of the solenoid valve.



**FIGURE 5-2:** Solenoid Valve Driver.

### 5.3 Incandescent/Halogen Lamp Driver

The combination of an MIC5060 and a power FET makes an effective driver for a standard incandescent or halogen lamp load. Such loads often have high inrush currents, as the resistance of a cold filament is less than one-tenth as much as when it is hot. Power MOSFETs are well suited to this application as they have wider safe operating areas than do power bipolar transistors. It is important to check the SOA curve on the data sheet of the power FET to be used against the estimated or measured inrush current of the lamp in question prior to prototyping to prevent “explosive” results.



**FIGURE 5-3:** Halogen Lamp Driver.

## 5.4 Relay Driver

Some power relay applications require the use of a separate switch or drive control, such as in the case of microprocessor control of banks of relays where a logic level control signal is used, or for drive of relays with high power requirements. The combination of an MIC5060 and a power FET also provides an elegant solution to power relay drive.

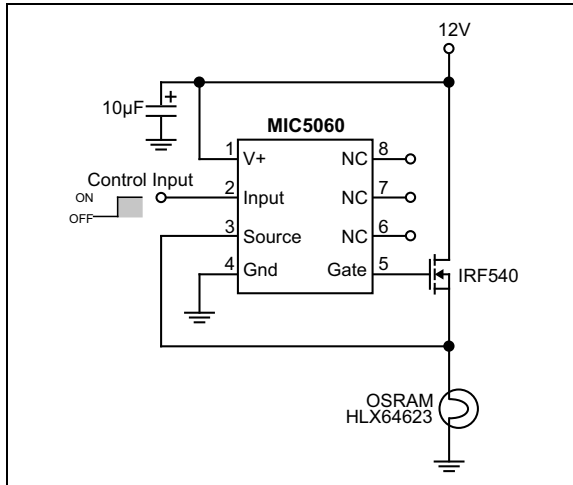


FIGURE 5-4: Relay Driver.

## 5.5 Motor Driver with Stall Shutdown

Tachometer feedback can be used to shut down a motor driver circuit when a stall condition occurs. The control switch is a 3-way type; the “START” position is momentary and forces the driver ON. When released, the switch returns to the “RUN” position, and the tachometer’s output is used to hold the MIC5060 input ON. If the motor slows down, the tach output is reduced, and the MIC5060 switches OFF. Resistor “R” sets the shutdown threshold.

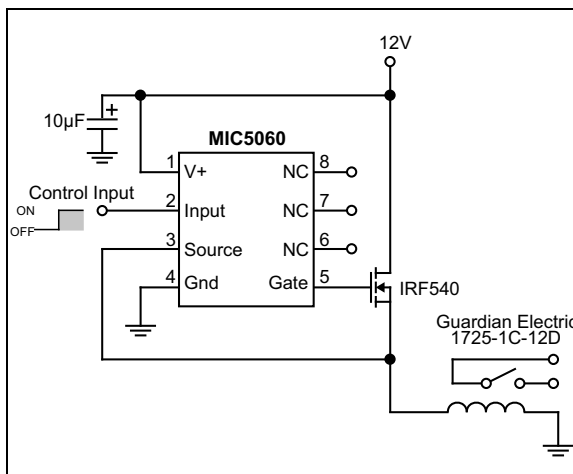


FIGURE 5-5: Motor Stall Shutdown.

## 5.6 Simple DC-DC Converter

The simplest application for the MIC5060 is as a basic one-chip DC-DC converter.

As the output (Gate) pin has relatively high impedance, the output voltage shown will vary significantly with applied load.

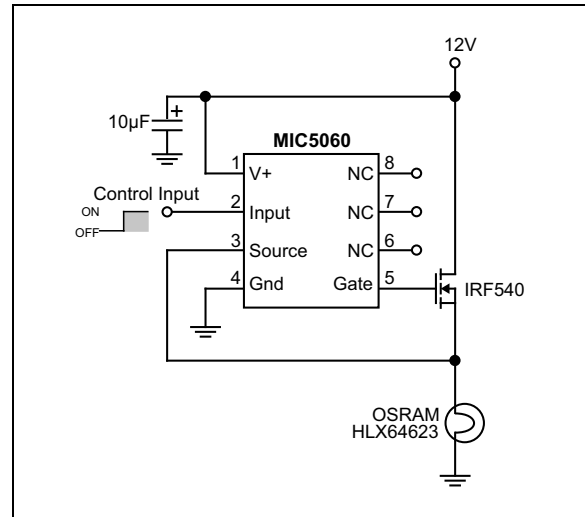


FIGURE 5-6: DC-DC Converter.

## 5.7 High-Side Driver with Load Protection

Although the MIC5060 is reverse battery protected, the load and power FET are not, in a typical high side configuration. In the event of a reverse battery condition, the internal body diode of the power FET will be forward biased. This allows the reversed supply access to the load.

The addition of a Schottky diode between the supply and the FET eliminates this problem. The MBR2035CT was chosen as it can withstand 20A continuous and 150A peak, and should survive the rigors of an automotive environment. The two diodes are paralleled to reduce switch loss (forward voltage drop).

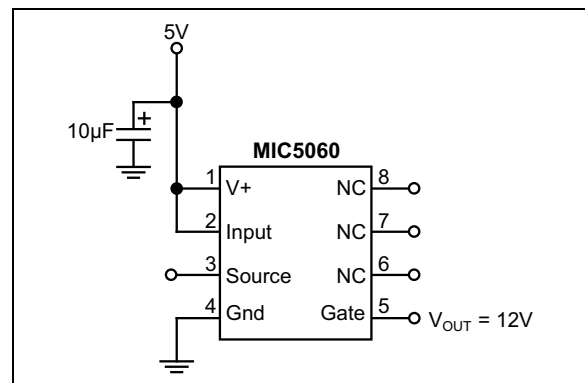


FIGURE 5-7: High-Side Driver with Load Protection.

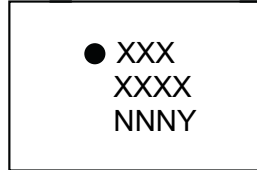
# MIC5060

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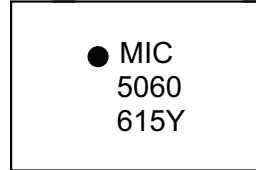
## 6.0 PACKAGING INFORMATION

### 6.1 Package Marking Information

8-Lead VDFN\*



Example



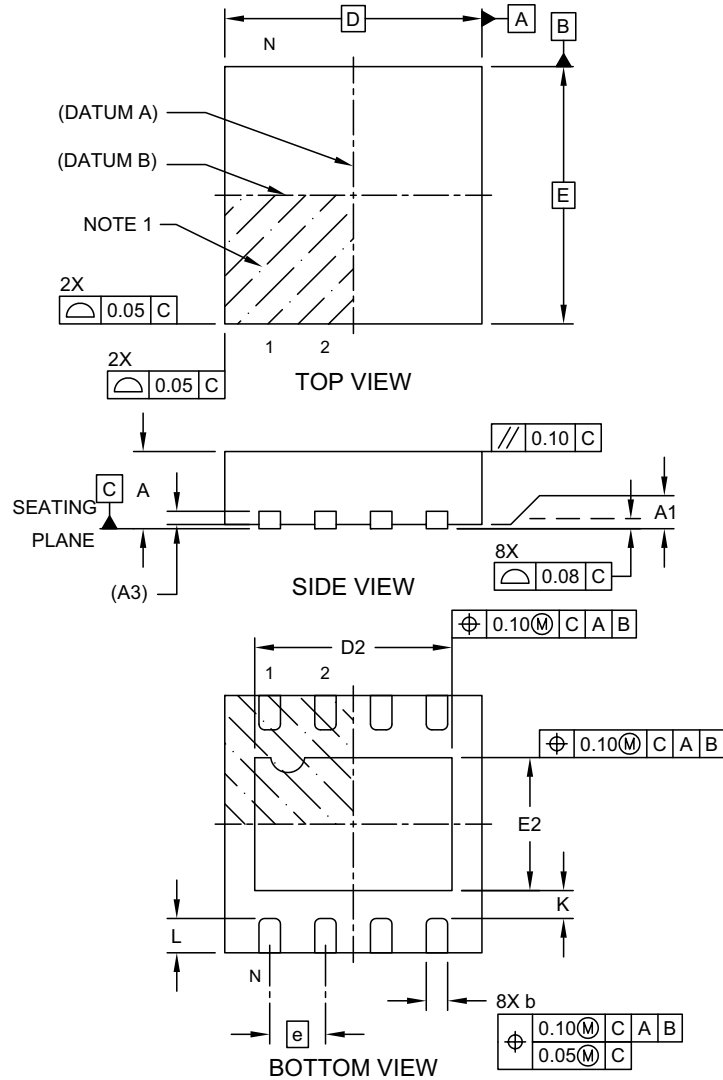
<b>Legend:</b>	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.
	•, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).
<b>Note:</b>	In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.	
	Underbar ( _ ) symbol may not be to scale.	

## 8-Lead VDFN Package Outline and Recommended Land Pattern

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>

### 8-Lead Very Thin Plastic Dual Flat, No Lead Package (JMA) - 3x3x0.9 mm Body [VDFN] Micrel Legacy Package DFN33-8LD-PL-1

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Microchip Technology Drawing C04-1021 A Sheet 1 of 2

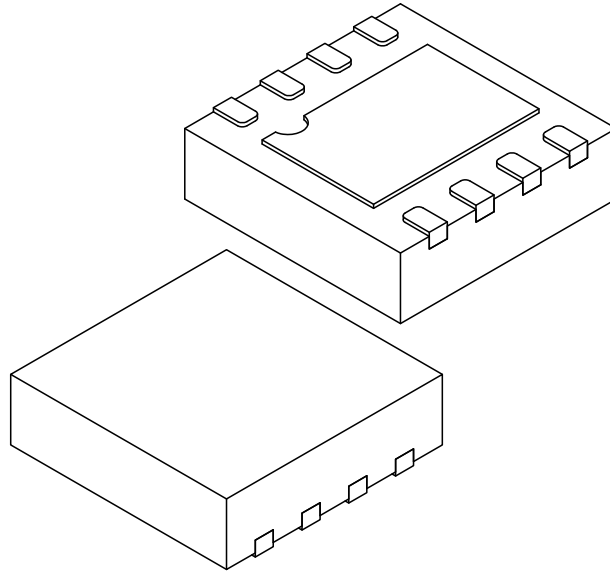
# MIC5060

## 8-Lead VDFN Package Outline and Recommended Land Pattern

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>

### 8-Lead Very Thin Plastic Dual Flat, No Lead Package (JMA) - 3x3x0.9 mm Body [VDFN] Micrel Legacy Package DFN33-8LD-PL-1

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Number of Terminals	N	8		
Pitch	e	0.65 BSC		
Overall Height	A	0.80	0.85	0.90
Standoff	A1	0.00	0.02	0.05
Terminal Thickness	A3	0.203 REF		
Overall Length	D	3.00 BSC		
Exposed Pad Length	D2	2.25	2.30	2.35
Overall Width	E	3.00 BSC		
Exposed Pad Width	E2	1.50	1.55	1.60
Terminal Width	b	0.20	0.25	0.30
Terminal Length	L	0.35	0.40	0.45
Terminal-to-Exposed-Pad	K	0.20	-	-

**Notes:**

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated
3. Dimensioning and tolerancing per ASME Y14.5M  
BSC: Basic Dimension. Theoretically exact value shown without tolerances.  
REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-1021 A Sheet 1 of 2

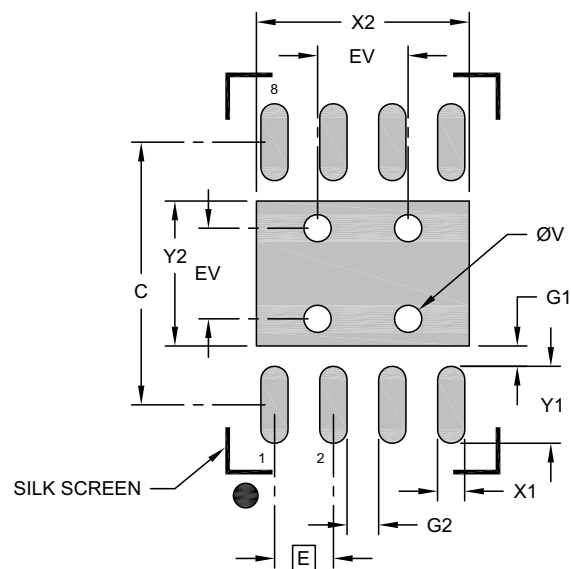


## 8-Lead VDFN Package Outline and Recommended Land Pattern

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>

### 8-Lead Very Thin Plastic Dual Flat, No Lead Package (JMA) - 3x3x0.9 mm Body [VDFN] Micrel Legacy Package DFN33-8LD-PL-1

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



### RECOMMENDED LAND PATTERN

Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Contact Pitch	E		0.65 BSC	
Optional Center Pad Width	X2			2.35
Optional Center Pad Length	Y2			1.60
Contact Pad Spacing	C		2.90	
Contact Pad Width (X8)	X1			0.30
Contact Pad Length (X8)	Y1			0.85
Contact Pad to Center Pad (X8)	G1	0.23		
Contact Pad to Contact Pad (X6)	G2	0.35		
Thermal Via Diameter	V		0.30	
Thermal Via Pitch	EV		1.00	

**Notes:**

- Dimensioning and tolerancing per ASME Y14.5M  
BSC: Basic Dimension. Theoretically exact value shown without tolerances.
- For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process

Microchip Technology Drawing C04-3021 Rev A

# MIC5060

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NOTES:

## APPENDIX A: REVISION HISTORY

### Revision A (November 2021)

- Converted Micrel document MIC5060 to Microchip data sheet DS20006615A.
- Minor text changes throughout.

# MIC5060

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NOTES:

## PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

<u>PART NO.</u>	X	X	XX
Device	Junction Temperature Range	Package	Media Type
<b>Device:</b> MIC5060: Ultra Small High-Side MOSFET Driver  <b>Temperature:</b> Y = -40°C to +85°C (RoHS Compliant)  <b>Package:</b> ML = 8-Lead VDFN  <b>Media Type:</b> TR = 5,000/Reel			

**Examples:**

a) MIC5060YML-TR: Ultra Small High-Side MOSFET Driver, -40°C to +85°C Junction Temperature Range, 8-Lead VDFN, 5,000/Reel

**Note 1:** Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

# MIC5060

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NOTES:

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